INVESTIGATING THE LINKAGE BETWEEN OBSERVED AND PERCEIVED PHYSICAL WORKSTATION CHARACTERISTICS: A CASE STUDY OF EMPLOYEE SATISFACTION, PERFORMANCE, AND COMFORT

A Thesis

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by

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ABSTRACT

Background: As offices change and employees spend more of their lives at work, managers and designers need to understand the relationship between employees and their work environment to spend investment dollars wisely. This study investigated the efficacy of various physical workstation environment characteristics in a medical office building (MOB) using observation and employee survey responses.

Method: This was a cross-sectional exploratory study measuring both the observed physical work environment and employees' perceptions of their workstation satisfaction, comfort, and performance in a MOB.

Results: Findings suggest that employees seek to improve comfort ratings for acoustics, privacy levels, and access to daylight and nature views. No moderating nor main effects were seen for satisfaction or performance, but comfort ratings did show main three main effects.

Discussion: The study highlighted opportunities to enhance employee comfort, performance and satisfaction using the physical environment. These findings inform and identify future research opportunities for MOB design.

BIOGRAPHICAL SKETCH

Born in Upstate New York and a Midwesterner at heart, Teresa Bevacqua decided to return to the Empire State to begin her Master's in Facility Planning and Management in 2017. Prior to this she was working as a space planning assistant at The Ohio State University, her alma mater, where she graduated with a degree in City and Regional Planning and a minor in Spanish. She credits this job with adjusting her trajectory and teaching her that there's more to the planning realm than focusing on outdoor public spaces. Her background knowledge and expertise in stakeholder engagement and psychology of urban spaces provided her with a unique perspective that assisted her coursework completion. During her time at Cornell in the department of Design and Environmental Analysis, she took classes in research and environmental psychology, project management, workplace strategy, and hospitality and healthcare design. She also became a registered Evidence-Based Design Accreditation and Certification (EDAC) practitioner. After graduation, she will be escaping the Ithaca weather and taking her talents to Florida where she will start a new job as an Occupancy Planner for a financial services firm.

Dedicated to my family, for their unwavering support even in the most difficult of times.

Mom, I wish you were here to finished version of this.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

The average employee spends over 90,000 hours of their life at work (Sitkus, 2017). This equates to roughly 10.25 years of an employee's life. The Center for Disease Control rates the average life expectancy for Americans as 78.6 years, meaning that almost 1/8 of an employee's life is spent working (Center for Disease Control, 2016). Thus, employee health, satisfaction, and performance should be a focus both from a public health and organizational standpoint. A study in 1996 defined a healthy workplace as an environment that "maximizes the integration of worker goals for well-being and company objectives for profitability and productivity" (Sauter, Lim, & Murphy, 1996; Gratwich, Gottschalk, & Munz, 2006). This indicates that the integration of health and wellness into the workplace is not a new idea. Therefore, employers and facility managers should be increasingly concerned with allocating their capital expenditure budget to workplace design projects that may provide the most benefit to employee health and satisfaction. Such attention may increase retention rates as people feel happier and more cared for by their employers, and likely have performance impacts that will favor the company as well (Sapio Research, 2017).

Employees may be more satisfied with their workstation comfort, and performance when they are less stressed and burdened at work. Workplace stress and fatigue occur with an overwhelmed mental state influenced by both personal and organizational (psychosocial) factors, as well as physical environmental factors (Vischer, 2007a). The physical environment of the workplace is one variable that can add burden and therefore negatively affect performance

(Vischer, 2007a; Cooper & Dewe, 2004). Research has also indicated when employees feel little to no control over the physical work environment these stressors may be especially exacerbated (Vischer, 2007a).

Based on the comfort theory model as described by Vischer, McCuaig, Melillo, & Nadeau (as cited in Preiser & Vischer, 2004), the characteristics of the work environment that may affect employees' perceived satisfaction, comfort, and performance within their work environment can be summarized in ten variables that facilitate the completion of work-related tasks (Preiser & Vischer, 2004). Many of these are macro-level and related to the facility's ambient environment, while others reflect the physical layout of an employee's individual workstation. These include workstation comfort, thermal comfort, air quality, privacy, lighting quality, noise control, spatial comfort, collaborative work, daylighting, and safety.

After summarizing the literature, a 2018 study applied these 9 environmental characteristics in assessing perceived health and performance in worker's in health care settings: noise level, privacy, temperature, air quality, view of nature, natural light, artificial light, comfortable furniture and appropriately size workstations (Zadeh, Shepley, Owora, Dannenbaum, Waggener, & Chung, 2018).

The role of the physical environment on health and performance can be described by Gibson's Theory of Environmental Affordance. Based on this theory the surrounding environment "affords" an individual or user by providing the means of doing something, either in a positive way or a negative way (Gibson, 1979). This describes the transactional nature between the environment and a user, and how they both can affect each other. If the physical environment facilitates the completion of one activity but hinders another by nature of the design, we as designers and facility managers are responsible to alleviate these

miscommunications. The transactional relationship between the user and their physical environment must be remembered and respected, and therefore is integral to the design of this study.

These sections summarize and extensive review of literature by this author on the environmental characteristics and their role on employees' perceived satisfaction, comfort, and performance within their work environment.

1.2 Literature Review

1.2.1 Workstation Comfort

According to Vischer and Fischer, the variable of workstation comfort encompasses the characteristics relating to the size and storage allocated to each employee. They break down this factor into four metrics: the adequacy of work surfaces, work storage spaces, the dimensions of workstation, and personal storage (Vischer & Fischer, 2005). The amount of space allocated to each employee can vary greatly, as can the type of workstation they are given. In the United States, this may depend largely on job hierarchy. The International Facility Management Association (IFMA) distributes benchmarks every few years highlighting the average space allocated per employee office displayed in Table 1-1 (Voss, n.d.; International Facility Management Association, 1997).

Job title	Recommended square feet per employee
Upper management	280
Senior level management	193
Middle management	142
Senior professional	114
Technical/professional	92
Senior clerical	84
General clerical	73

Table 1-1 Recommended Square Footage for Various Office Types

The current trends in centralization of teams and push toward open concept office plans are also noted to account for differences in noise levels and levels of privacy. This shift heightens the need for individual control at one's workstation (Zadeh et. al., 2018; O'Neill, 2008). When the primary work zone allocated to employees is largely composed of shared spaces, research suggests a need for the availability of ancillary spaces to be used as flexible space. This provides employees the potential to have access to spaces that meet their individual and group needs (Lee & Brand, 2005).

The need for personal storage and work storage is tied to the idea of organization. Studies have indicated that visual clutter at the workstation may be linked to increased stress levels and lower focus (Alton, 2017). Desk clutter may also elicit a semblance of crowding or employees not being in control of their personal workstation (Heerwagen, Heubach, Montgomery, Weimer, 1995).

1.2.2 Electric Lighting

Improper or inefficient lighting can prompt eye strain or headaches if too bright or dim for vision to facilitate task completion. During office work such as charting and documentation, healthcare workers prefer that their workstation has natural lighting available. Windowless spaces with only "fluorescent lights [have the potential to] create unpleasant glare and harsh environments" in these settings (Zadeh et. al., 2018). Various lighting fixtures (e.g. Task light, ambient light) are needed to ensure that employees can meet the tasks they experience on the job. Task lighting (i.e.: a desk lamp) can be more flexible than overhead lighting and may allow the user more controllability of their workstation (Begemann, van den Beld, & Tenner, 1997). For office settings, the recommended lighting levels at employee workstations is 500 lux (United States General Services Administration, 2019). The Occupational Safety and Health Administration (OSHA) suggests that the lighting levels for paper tasks and the usages of cathode ray tube monitor displays should be between 215 and 538 lux, whereas LCD monitors may require lighting of up to 785 lux (Occupational Safety and Health Administration, n.d.).

From a non-visual perspective, light can also influence cognitive performance and alertness through neurobiological pathways (Roberts, 2010). There have been several studies investigating the effect of cool white light imitating natural light on circadian rhythms, alertness and mental performance levels (Pauley, 2004; Cajochen, Münch, Kobialka, Kräuchi, Steiner, et al., 2005). 'Cool' white lighting (4000 K) is said to emit a bluish tinted light, whereas artificial 'daylight' is a form of white lighting that emits an even bluer light (5500 K) at 500 lux (Commission Internationale De L'Eclairage, 1986; Knez, 2001). Knez found that long-term recognition and long-term recall performance were higher at the 'warm' condition rather than the

'cool' or artificial 'daylight' condition, though none of the three conditions seemed to affect mood in this study (Knez, 2001).

1.2.3 Spatial Comfort

The choice of color in the office space may affect employee mood and activity levels. In a study of academia, student study spaces that were painted pastels and lighter paint colors were perceived as more complimentary than darker, more vivid colors. Pale yellows and blues were shown to have the greatest increase on activity, motivation, and concentration levels (Al-Ayash, Kane, Smith, & Green-Armytage, 2016). Studies suggest in areas where relaxation is needed, light blues, soft greens, and other subdued tones may increase feelings of calm and security (Al-Ayash, Kane, Smith, & Green-Armytage, 2016; Kaya & Crosby, 2006). Another study suggests public spaces that facilitate social interaction and encourage collaboration should be painted more vibrant colors such as reds, purples, and oranges due to their perceived association with increased activity (Kaya & Crosby, 2006).

a. Ergonomics

Including ergonomic features such as standing desks, supportive desk chairs, computer equipment (keyboards, mice, tilting screens), and comfortable furniture (i.e.: lumbar supporting chairs, varied furniture layouts) can lead to reduced rates of sedentarism, back, neck, and wrist issues in the workplace (Occupational Safety and Health Administration, n.d.). The OSHA also recommends that employees should use good working posture while sitting at a computer workstation, which is defined as having hands, wrists, forearms, and thighs parallel to the floor, keeping head and shoulders in line with the body and relaxed, elbows bent roughly 90 to 120

degrees, and back supported against a lumbar-supported chair (Occupational Safety and Health Administration, n.d.).

Workstations that are flexible may better support employee work and allow for the changing of positions and breaks, which are also recommended by OSHA (Vischer, 2008; (Occupational Safety and Health Administration, n.d.). Implementing ergonomic features may reduce costs due to musculoskeletal issues. A study conducted by the Washington State Department of Labor and Industries found a reduction in these costs of 64% on average, which could make them more attractive investments for companies (Department of Labor and Industries, 2000; Rose, Orrenius, & Neumann, 2013).

1.2.4 Privacy

Privacy is the allowance of a person to control one's accessibility of others and is another facet of environmental control affected in the workplace (Vischer, 1996; Vischer, 2008; Bodin Danielsson & Bodin, 2009). Privacy can encompass the physical proximity and visual permeability of other employees, and the acoustic privacy from other conversations and distractions (Zadeh et. al, 2018). Acoustic privacy includes noise levels in the workplace, which may cause issues with performance and recall, among other consequences (Becker, 1981; Sundstrom, 1986). In today's workplaces, as offices are increasingly becoming open-concept and collaborative, creativity and interaction may impede visual and acoustic privacy as additional workers are being stationed in unassigned workstations or in cubicles. This arrangement can affect worker's access to privacy, which is an innate human need (Vischer, 1996; Bodin Danielsson & Bodin, 2009). Studies suggest links between inadequate privacy and lower perceived employee productivity levels (Maarleveld, Volker, & van der Voordt, 2009).

1.2.5 Noise Control

Office noise levels can contribute to increased distraction, lowered performance, and elevated levels of stress due to the perception of lack of individual control (Bodin Danielsson, 2010a). Variations in types of workstations and levels of office privacy can affect employees' tolerance of changing noise levels; some employees may thrive working in these conditions whereas others could be overwhelmed due to the increase in stimuli (Van der Voort, 2004). This has the potential to cause employees to become distracted due to the noise affected by office workstation layout and the ambient conditions (Mulville, Callaghan, & Isaac, 2016). In a 2005 study, researchers found that respondents working in cubicle settings were less satisfied than their single-occupant counterparts, as they were subject to coworkers talking on the phone; unintentionally eavesdropping during private conversations; and various office chatter (Jensen & Arens, 2005). Noise may also disrupt memory recall when employees exhibit exhaustion and low motivation, impacting job performance (Jahncke et al., 2011).

1.2.6 Daylighting

The inclusion of windows has been shown to be effective in reducing staff stress, increasing satisfaction in both healthcare and office workplaces, and providing opportunities for employees to be exposed to daylight (Chang & Chen, 2005). Access to daylight in the workplace may also aid in preventing sleep issues, heightening alertness, improving mood, and reducing instances of depression (Begemann, van den Beld, & Tenner, 1996).

Beyond the physiological effects, studies of healthcare facilities have shown that staff exposed to over three hours of daylight per shift tend to have higher job satisfaction levels and show fewer signs of stress than employees who aren't (Ulrich, 2008; Alimonglu & Donmez,

2005). Access to daylight during the workday may therefore be important for employee health and could contribute to their workplace satisfaction.

a. Nature Views

Studies have suggested a link between the presence of windows with nature views and decreased stress and anxiety levels (Chang & Chen, 2005). Kaplan based an entire theoretical perspective on the importance of the restorative aspects of nature. He argued that the concept of "getting away" largely means going out and being exposed to nature (Kaplan, 1995). Limited exposure to nature views may also be restorative as described in Kaplan and Kaplan's micro-restorative theory (Kaplan & Kaplan, 1989; Kaplan, 1995). While in the US window views aren't always a necessary facility design requirement for workplaces, studies have shown that windows of nature views, or offices that included plants, were better at reducing tension and anxiety in workers than when exposed to situations with city views, or where neither windows or plants were present (Chang & Chen, 2005). There are also certain natural elements considered to be more restorative than others, as humans have an affinity for nature that promotes survival and safety. These scenes may include "calm or slowly moving water, verdant foliage, flowers…[and] park-like or savannah-like properties [with] scattered trees [or] grassy understory" (Ulrich, 1993, 1999; Ulrich & Gilpin, 2003).

1.3 Evidence-Based Design

Evidence-based design (Stichler & Hamilton, 2008) is a widespread trend which initiated in healthcare research and was expanded to other settings. It has been described as a conscious, unbiased method of using current evidence to inform both clients and designers/managers to make design decisions regarding a single project (Stichler & Hamilton, 2008). This method is

largely based on the scientific approach to facility design decisions, and allows for continuous feedback loops of research, implementation, and interpreting results per Tannen, in Whitemyer (2010) (Whitemyer, 2010). The goals of evidence-based design are three-fold: to positively affect outcomes; generate cost savings; and directly impact the care, safety, and experiences of patients, visitors, and staff (Neo, 2016). Evidence-based design is becoming increasingly accepted in other industries, such as in the design of academic settings, hospitality, and cultural settings, prisons, and even workplace design (Whitemyer, 2010).

We summarized the literature and conceptual frameworks, including the physical workstation environment characteristics, across office and healthcare settings and categorized them into these six groups: workstation comfort, lighting quality, spatial comfort, privacy, noise control, and daylighting. These key characteristics found from literature were used for this study.

1.4 Research Goals and Objectives

From a facility planning design and management perspective, the primary goal of this research was to identify the characteristics of the physical workstation environment in a MOB setting linked to improving employee satisfaction, comfort, and performance. The secondary goal was to compare the researcher's perspective and employees' perspective in evaluating environmental effectiveness.

1.5 Research Questions and Hypotheses

The research questions that spurred this study's development are:

1. What are the most essential components of the physical workstation environment when it comes to the MOB employees' comfort, satisfaction and performance?

2. Do associations exist between a researcher's evaluation of the physical features of the workstation environment and the employees' evaluation of those features in terms of perceived satisfaction with their workstation, performance, and comfort?
3. Are these factors impacted by the demographic features of age, time spent at workstation, length of time at company, and gender?

The following are the hypotheses for this study:

Hypothesis 1: As informed by the physical workstation environment characteristics highlighted in literature from office and healthcare settings, we hypothesize access to daylight, privacy, and noise due to office typology will be rated as essential components influencing an employee's workstation comfort. This will be exhibited through polarized comfort ratings of daylight, privacy, and noise ratings when comparing office type.

Hypothesis 2: The physical workstation environment characteristics measured by researcher will be correlated to the employees' perceived quality of these characteristics.

Hypothesis 3: Demographic factors moderate the linkage between each physical workstation environmental characteristic and satisfaction, comfort, and performance.

CHAPTER 2

METHOD

2.1 Study Design

This is a cross-sectional study that applied qualitative and quantitative methods to evaluate the effectiveness of physical workstation environment factors in supporting satisfaction and comfort of office workers in a MOB. For qualitative measurement of the target variables this study employed participant surveys to gather response data, and for quantitative measurement the study applied an environmental checklist developed based on a review of literature on office settings by the researcher.

2.2 Site and Setting

The study was conducted in 37,000 square foot medical/dental manufacturing and distribution office building in Upstate New York. The facility is in the beginning stages of a 100,000 square foot expansion, expected to quadruple their space. Currently, the facility occupies one floor and employs 110 people who work in a variety of office types including private offices, shared offices, cubicles, laboratory settings, production lines, and light manufacturing lines.

2.3 Participants

To be eligible to participate in the study, participants had to be a full-time office worker between the ages of 18 and 75 who performed their job requirements while working in either individual or shared physical workstations in the MOB studied. In the studied population, 51 employees were deemed eligible to participate based on their workstation type.

2.4 Study Measures

The independent variable was measured through a physical workstation environmental checklist, the Workstation Visual Assessment Tool (WVAT), developed by this author using a review of relevant literature. The tool should allow the researcher to score the workstations objectively based on the availability of various elements of the physical workstation environment. The dependent variable was measured by Vischer & Fischer's subjective employee Building-in-Use survey (BIU) (Vischer & Fischer 2005; Vischer, 1996) assessing the employees' perceived satisfaction, comfort, and performance within their physical workstation environment. This allowed for triangulation of the outcome measure and also enabled drawing correlations between the users' qualitative perception and researcher's quantitative assessment of the environmental affordances.

These sections explain the study measurement tools for the independent (environmental characteristics) and dependent (employees' satisfaction, comfort and performance) variables:

2.4.1 WVAT Checklist Development

The WVAT was developed by this author in a two-stage process to measure the environmental characteristics quality and was developed based on a literature review and a mini-

pilot study. First, a review of literature was conducted to identify physical environment characteristics in the workplace that safeguard or hinder employee workstation satisfaction, comfort, and performance. The environmental characteristics identified were summarized and categorized in chapter one of this thesis. Then, the list of found variables to assess the relevant environmental characteristics were compared with the dimensions of functional comfort used in the BIU survey (Vischer & Fischer 2005; Vischer, 1996), which enables measurement of user's feedback on the environmental characteristics. Only the variables also present in the Vischer surveys were included in the checklist for this study to allow for a comparison between the measures. The list of dimensions of the WVAT developed in this thesis included: access to daylight, work surfaces, privacy, voice noise, noise distraction, how bright it gets, electric lighting options, view from windows, desk and chair types, and workstation layout.

For each physical environment variable, the qualities and characteristics explained in the literature review was used to create ranking or evaluation criteria for each workstation characteristic. A full copy of this tool is in Appendix A. Then, a mini-pilot study was used to assess the robustness of those criteria with the following procedure. Two researchers filled out the WVAT for a sample of 5 workstations with a variety of features. These 5 workstations were found from free stock images of office layouts by the author. The researchers compared their responses to ensure the checklist descriptions enabled objective assessment with minimal subjective perception of each evaluator. In areas where agreement was not present between the researchers' completed checklists, the question was modified or eliminated. The final checklist only included the questions consistently responded across the 5 settings. The checklist was then developed digitally using Qualtrics software, Version 04/2019 to be used in the test site (Qualtrics, Provo, UT).

2.4.2 Amended Version of Vischer's Building-In-Use Survey

Employees' perceived satisfaction, comfort, and performance of the physical workstation environment was measured by the Vischer and Fischer's 2005 BIU survey tool (Vischer & Fischer, 2005; Vischer, 1996). The Building-In-Use survey tool was developed to put the measurement of human opinion at the forefront of the study of the physical work environment (Vischer & Fischer, 2005). This method follows the functional comfort model as a method of investigating the user experience as it relates to employee satisfaction, performance, and comfort at their workstation. This contrasted with both the Post-Occupancy Evaluation (POE) method (Preiser, Rabinowitz, & White, 1988), and the Building Performance Evaluation metric (Preiser & Vischer, 2004; Bon, 1989). Both of those are diagnostic measures of a building and its occupants after a period of time following a move/redesign of the physical environment (POE), or continuous feedback loops of user input and objective evaluation using tools that affect all aspects of planning and development (BPE) (Preiser & Vischer, 2004; Bon, 1989).

The BIU survey was different, and enabled participants to rate ten physical workstation environment characteristics based on their perceived functional comfort. The variables included workstation comfort, air quality, thermal comfort, lighting quality, spatial comfort, privacy, noise control, collaborative work, daylighting, and safety. The full BIU survey included 51 questions to be rated by participants using a 1-5 Likert scale. However, only those related to the physical work environment variables that overlapped with our literature review and included in the WVAT checklist were utilized in this study. This reduced the survey to 23 questions on the topics of spatial comfort, daylighting and nature, workstation comfort, privacy, lighting quality, and noise control. Four demographic questions were added to the survey for a total of 27 questions. These demographic questions can be found in Appendix B.

2.5 Ethical Considerations

This study was approved by Cornell University's institutional review board (#1903008674). The participating facilities' leadership also approved the study. No identifiable employee contact information was collected as a part of this study.

Since the study was anonymous the researcher used a coding system to correlate the measurements without collecting participant identifiers. Each workstation was assigned a numerical code only available to the researcher. This same code was on the back of the BIU survey to allow for comparisons to be drawn between the subjective and objective measures. Once data were matched these codes were removed and the floor plan discarded. A summary of the findings was shared with the facility for their use.

2.6 Data Collection

Employees received an email from the general manager notifying them of the study before recruitment began. The researcher recruited potential participants individually by walking by the workstations. Participants were given a $5 Starbucks or Dunkin' gift card for participating. Employees had to indicate a token of appreciation was given by marking a check on the compensation form. The following describes the collection of data for the independent and dependent variables in further detail.

2.6.1 Independent Variables (Physical Workstation Environment Characteristics)

The researcher conducted a walk-through evaluation for each workstation that received a paper survey. She utilized a hand held iPad to complete the WVAT checklist for each

workstation. This was done independently with no interaction or input from the users. The collection of workstation observations took one day to complete.

2.6.2 Dependent Variables (Employee Perception of Satisfaction, Comfort, and Performance)

The paper surveys were distributed to eligible employees on the morning of April 3 and collected at the end of the workday (between 3 and 4 PM). The researcher offered a copy of the paper survey during a walk-through of the facility and answered questions employees had. Employees were notified in advance by management via email they may be asked to fill out a survey. The surveys also had a short introduction from the researcher on the front, along with the informed consent documentation stating that the surveys were anonymous, and their participation was voluntary. The anticipated completion time for the survey was 25 minutes, however it was not enforced, and participants did not have to complete the study all in one sitting. The majority of participants completed it in less than this. A few demographic questions were also included to gather employee census data.

2.7 Data Analysis

The responses to the BIU surveys were imported into Qualtrics Version 04/2019 by the researcher and the Excel (Version 16.27) and SPSS (Version 26) data files were exported for further analysis. The first type of analysis interpreted demographic data and descriptive statistics of the BIU questions to see if there were any reporting trends in the data. This included determining the internal consistency of the questions on the BIU to see if there were correlations between the employee responses for similar questions, examining employee sentiment data for

common themes, counting employee responses and calculating the measures of central tendency of the BIU, and organizing the categorical responses observed using the WVAT. The second method of analysis looked at the response count of the BIU survey questions versus the WVAT's checklist answers to compare descriptive statistics in cross-tabulations using the above data. The third method of analysis utilized binomial logistic regressions and linear regressions to investigate the potential associations between the physical workstation environment characteristics and employees' workstation satisfaction, average comfort, and performance levels. This included going question by question of the BIU and conducting regressions against the reported satisfaction, average comfort, and performance ratings separately, to see if there was a significant association between the variables by their reported p-values. The outcomes of these are displayed in Tables 3-15 to 3-17.

These allowed for comparisons to be made among both data sets. This included regression analyses to determine if there are physical aspects of the workstations that employees used to adapt to their work environment or are perceived as more important than others to their performance, workstation satisfaction, or comfort. This facilitated the reporting of which aspects of the physical work environment were most effective at aiding or hindering the completion of work and provided the highest opportunity to influence future design recommendations and best practices. These findings can be used to spur policy and design recommendations for future facility renovations, including the new expansion.

The breakdown of the aspects of the physical workstation environment characteristics, the WVAT checklist questions, and BIU questions are listed in Tables 2-1 and 2-2 below.

Physical work environment characteristic	WVAT Checklist Question #	BIU Question #
Spatial comfort	14, 16, 17	3, 8
Workstation comfort	2, 3, 4	1, 4, 5, 6, 7
Daylighting	6, 7, 9, 25	2, 20, 21
Privacy	2, 3, 4, 19	1, 14, 15, 16
Lighting quality	6, 7, 8	17, 18, 19
Noise control	2, 3, 4, 19	1, 9, 10, 11, 12, 13

Table 2-1 Physical Work Environment Characteristics and Corresponding Study Questions

Functional comfort item	Questions regarding	Expert observed	User surveyed
Spatial comfort	Type of desk	X	
	Ergonomic chair availability	X	Chair comfort
	Other office furniture included	X	
	Office layout		X
Workstation comfort	Type of office	X	X
	# people in office	X	
	# desks in cubicle arrangement	X	
	Office size		X
	Work-surfaces		X
	Work storage		X
	Personal storage		X
Daylighting	Access to individual window	X	
	Access to daylight	X	X
	Nature view from window	X	
	Distance to nearest window	X	X
Privacy	Type of office	X	X
	# people in office	X	
	# desks in cubicle arrangement	X	
	Noise blocking features	X	
	Visual privacy	Type/# people	X
	Conversation privacy	Type/# people	X
	Telephone privacy	Type/# people	X
Lighting quality	Type of lighting at workstation	X	
	Overall lighting comfort		X
	How bright it gets		X
	Low light levels		X
Noise control	Type of office	X	X
	# people in office	X	
	# desks in cubicle arrangement	X	
	Noise blocking features	X	
	Noise distractions	Type/# people	X
	Background noise levels	Type/# people	X
	Specific voice or equipment noises	Type of office	X
	Noise from ventilation		X
	Noise from outside the building		X

Table 2-2 Comparisons Between Expert Observations and User Survey Responses

CHAPTER 3

RESULTS

3.1 Respondent Demographics

Table 3-1 illustrates a descriptive summary of the respondent demographics. Surveys were distributed to 51 employees and 41 completed the study (response rate of 80%). To summarize, the majority of participants were under the age of 49, with a mean age of 40. Male respondents also outnumbered women respondents 2:1. 80% of participants had been seated at their current workstations for less than four years, with almost 34% being stationed there for less than one year. The majority of respondents (57%) have been at the company for less than five years.

Characteristics of the Study Sample (N=41)	N	N (%)
Age distribution		
20-29	8	20%
30-39	13	32%
40-49	7	17%
50-59	8	20%
60-69	2	5%
Unclassified	3	7%
Gender		
Male	26	63%
Female	13	32%
Unclassified	2	5%
Time at Company		
Less than 1 year	8	20%
1 to 4 years	15	37%
5 to 9 years	5	12%
10 or more years	12	29%
Unclassified	1	2%
Time stationed at workstation		
Less than 1 year	14	34%
1 to 4 years	19	46%
5 to 10 years	5	12%
10 or more years	2	5%
Unclassified	1	2%

Table 3-1 Participant Demographic Data

3.2 Hypothesis One

Access to daylight, privacy, and noise due to office typology will be rated as essential components influencing employees' workstation comfort. This will be exhibited through high response counts and polarized comfort ratings when comparing the various office types.

First the overall mean employee comfort ratings were calculated for each question on the BIU, and then calculated for the responses of each office type. The internal consistency of the questions on the BIU was then determined, to see if there were correlations between the employee responses for similar questions. The sentiment data left by a few employees were interpreted to identify common response themes and for potential associations that may exist between these descriptive statistics and office type. The measures of central tendency were calculated to determine the count and average employee responses for each question on the BIU. The descriptive findings gathered by the observer on the WVAT were also organized by categorical response.

3.2.1 Mean Workstation Environment Comfort Ratings When Comparing Office Type

The following provides descriptive results on the employees' preferences on the most important physical workstation environment characteristics. Findings suggest that there are certain workstation environment characteristics that elicit polarized comfort, satisfaction, and performance ratings when broken down by observed office type.

Overall descriptive analysis showed the employees in this MOB are most comfortable with outside noise levels across all office types and show areas for improvement regarding their access to daylight and nature views, interior background noise, and privacy levels.

		Survey Rating	Type of Office Observed			
		Overall Sample	Private - Single Occupant	Private - Shared	Open - With Partitions	Open - No Partitions
		n=41	n=14	n=16	n=5	n=6
Mean Employee Reported Comfort Level (BIU Survey)	Noise Distractions	2.68	3.07	2.75	1.6	2.5
	Background Noise	2.90	3.07	2.75	2.4	3
	Voice & Equipment Noise	2.83	3	2.81	2.6	2.67
	Ventilation Noise	3.85	3.5	3.37	4.4	3.83
	Outside Noise	4.46	4.29	4.56	4.8	4.33
	Visual Privacy	2.95	3.57	2.5	3	2.67
	Conversation Privacy	2.68	3.21	2.38	1.6	3.17
	Telephone Privacy	2.73	3.29	2.63	1.6	2.67
	Overall Lighting Comfort	3.76	3.14	3.81	4	3.17
	Access to Daylight	2.71	2.64	3.06	1.4	2.5
	Access to Nature View	2.20	2.14	2.63	1.6	2
	Facilitates Work	3.29	3.86	3.38	2.6	3.33
	Workplace Satisfaction	3.33	3.64	3.56	2.8	3.33

Table 3-2 Mean of Reported Comfort Levels by Observed Office Type
Note: *The Likert scale is measured on a 1 to 5 scale where lower scores indicate lower comfort scores, or more areas of opportunity. Ratings with darker shading indicate lower comfort or satisfaction scores (two or below). Lighter shaded ratings indicate higher comfort or satisfaction scores. Light grey variables are comfort indicators, medium grey is satisfaction, and dark grey performance.*

3.2.2 Internal Consistency of BIU Items

It was necessary to test the internal consistency of the questions on the BIU survey as questions were eliminated from the original. The Cronbach alpha of the revised survey was 0.832, n=19. A summary of the inter-item correlation matrix is below, displaying questions with correlations above 0.80.

	Noise Distractions	Background Noise	Conversation Privacy	Telephone Privacy	Access to Windows	Nature View
Noise Distractions	1.00	.802	.634	.563	.135	.101
Background Noise	.802	1.00	.512	.391	-.011	.003
Conversation Privacy	.634	.512	1.00	.877	-.197	-.251
Telephone Privacy	.563	.391	.877	1.00	-.144	-.227
Access to Windows	.135	-.011	-.197	-.144	1.00	.867
Nature View	.101	.003	-.251	-.227	.867	1.00

Table 3-3 Highly Correlated Items on BIU Survey
Note: *Darker shades indicate a perfect correlation, seen as variables are measured amongst themselves. Lighter shades indicate strong correlations between two characteristics.*

3.2.3 Employee Sentiments

The BIU survey is largely standardized, allowing participants to select from predetermined answers. However, there is space for motivated employees to leave open-ended comments for the researcher to note. Twenty-two percent of respondents [9] left additional comments about their feelings of their workstation. A select few are described below.

A participant seated in a shared office commented: “My office is adequate to where I can get my work done. But I share the office and sometimes I cannot use or have access because the other person is having a meeting. Also my back is to the door, not a good feeling.”

A respondent in a private office said: “My line of work is generally in an office area, away from the noises of phones and conversations. It requires concentration and creativity, so distractions are negatively impacting my work and an "open concept" or cubicle would NOT be conducive to my line of work.”

Another employee mentioned: “There is no natural light in this part of the building.”

A participant in an open workstation reported: “As a department our open space is great for communication but makes privacy almost non-existent. You have to learn to "tune" others out in order to handle the outside noise coming through. It's cold!”

Another respondent in an open office explained: “My workspace is adequate due to lack of space in this office for new hires. I am out in the open so a lot of people walk by. This is distracting and annoying as there is no privacy. It does not hinder my performance but it is not ideal either. The lighting is blocked by my chair which creates shadows, which makes it challenging to see work in front of me.”

3.2.4 Measures of Central Tendency of BIU

Table 3-4 shows the number of participants that scored each Likert value by individual BIU survey question, and their respective measures of central tendency. Lower values indicate lower comfort/adequacy levels, or more room for improvement. Highlighted values indicate that the mean of this item fell below the “Neutral” condition (score less than 3).

Question	Likert Scale Items Uncomfortable - Comfortable 1	2	3	4	5	n	Measures of Central Tendency Mean	Median	Mode	σ
Furniture layout	1	9	10	13	8	41	3.44	4	4	1.12
Workstation size	0	5	8	14	14	41	3.90	4	4	1.02
Work-surfaces	1	4	8	17	11	41	3.81	4	4	1.03
Work storage space	2	4	14	9	12	41	3.61	4	3	1.16
Personal storage	2	5	13	9	12	41	3.59	4	3	1.18
Chair comfort	4	4	7	18	8	41	3.54	4	4	1.21
Noise distractions	4	18	9	7	3	41	2.68	2	2	1.11
Background noise	3	17	7	11	3	41	2.90	3	2	1.13
Voice & equipment noise	5	13	10	10	3	41	2.83	3	2	1.16
Ventilation noise	1	2	10	17	11	41	3.85	4	4	0.96
Outside noise	0	1	3	13	24	41	4.46	5	5	0.75
Visual privacy	3	15	11	5	7	41	2.95	3	2	1.22
Conversation privacy	9	14	5	7	6	41	2.68	2	2	1.39
Telephone privacy	6	16	7	7	5	41	2.73	2	2	1.27
Overall lighting comfort	0	2	16	13	10	41	3.76	4	3	0.89
How bright it gets	1	1	13	15	11	41	3.83	4	4	0.95
Low light levels	0	1	13	11	16	41	4.02	4	5	0.91
Access to daylight	12	9	9	1	10	41	2.71	2	1	1.54
Access to nature view	19	10	3	3	6	41	2.20	2	1	1.47

Table 3-4 Response Counts and Descriptive Statistics of BIU Survey Questions
Note: *Shaded ratings indicate lower comfort or satisfaction scores (three or below).*

3.2.5 WVAT Observational Data

Using the WVAT tool, the researcher collected data on a variety of workstation environment characteristics. The number of observations for each of these is listed in Table 3-5.

Expert Observations (N=41)		
Functional Comfort Characteristics	N	N (%)
Type of office		
Private - single occupant	12	29%
Private - shared	11	27%
Open - with partitions	10	24%
Open - without partitions	8	20%
Occupants in shared office/workstation		
N/A	23	56%
2	7	17%
3	3	7%
4	4	10%
5	4	10%
Access to windows with nature view		
Windows and nature view	10	24%
Windows without nature view	4	10%
No windows nor view	27	66%
Distance to windows		
Close to windows	11	27%
Over 5 feet from windows	3	7%
No access to windows	27	66%
Desk type		
Sitting only	38	93%
Standing only	2	5%
Combination desk	1	2%
Availability of adjustable chair		
Yes	39	95%
No	2	5%
Availability of acoustic ceiling tiles		
Yes	36	88%
No	5	12%
Availability of carpet		
Yes	31	76%
No	10	24%
Availability of fabric cubicle material		
Yes	7	17%
No	34	83%
Headphones available		
Yes	7	17%
No	34	83%

Table 3-5 Expert Observations Using WVAT

3.3 Hypothesis Two

The physical workstation environment characteristics measured by the researcher using observation will be correlated to the employees' perceived quality of these characteristics.

The following sections evaluate this research question. The response counts and measures of central tendency of the BIU and the descriptive findings from the WVAT referenced in hypothesis one were compared in cross-tabulations to investigate potential associations and see how well the responses from each tool matched. The findings show that there may be links between certain aspects of the physical environment and employees' reported rankings, such as lower rankings of conversation privacy and being seated in a cubicle setting.

3.3.1 Cross-Tabulations Comparing BIU and WVAT Questions

A major question of this research involved looking at objective observer responses from the WVAT versus employees' perceptions of various workstation environment characteristics using the BIU. The questions on the WVAT that relate to questions asked on the BIU are referenced in Table 2-2 in the methods section. The associations between these questions are investigated further in Tables 3-6 to 3-14.

		Type of Office Perceived				
		Private - Single	Private - Shared	Open - With Partitions	Open - No Partitions	Total
Type of Office Observed	Private - Single	12	1	0	1	14
	Private - Shared	0	10	4	2	16
	Open - With Partitions	0	0	5	0	5
	Open - No Partitions	0	0	1	5	6
	Total	12	11	10	8	41

Table 3-6 Cross-Tabulation of Type of Office Observed and Employees' Perception
Note: *Read left to right the above numbers are counts of how many respondents categorized their office type (the type of office perceived) as the type of office the researcher marked the employee's office as (the type of office observed). Shaded boxes indicate when the observed office type (from WVAT) and perceived office type (from BIU) correctly matched. The total reveals how many offices exist of each type.*

		Reported Chair Comfort			Total
		Uncomfortable - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	
Availability of Adjustable Chair	Yes	6	7	26	39
	No	2	0	0	2
	Total	8	7	26	41

Table 3-7 Cross-Tabulation of Availability of Adjustable Chair and Reported Comfort

		Access to Daylight			Access to Nature View			Total
		Uncomfortable - Comfortable			Uncomfortable - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Window Access in Work Area	Yes	2	2	10	3	2	9	14
	No	19	7	1	26	1	0	27
	Total	21	9	11	29	3	9	41

Table 3-8 Cross-Tabulations of Window Access and Reported Daylight and Nature Views
Note: *The following tables there are two different characteristics exhibited in one table – in this table they are access to daylight and access to nature. These are still measured on the 1 to 5 Likert scale, grouped in three categories each for simplicity, and should also be read left to right.*

		Visual Privacy			Conversation Privacy			Total
		Uncomfortable - Comfortable			Uncomfortable - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Number of People in Shared Office	1	8	5	10	12	4	7	23
	2	2	3	2	1	0	6	7
	3	3	0	0	2	1	0	3
	4	2	2	0	4	0	0	4
	5	3	1	0	4	0	0	4
	Total	18	11	12	23	5	13	41

Table 3-9 Cross-Tabulations of People in Shared Office and Reported Privacy Levels

		Telephone Privacy			Voice and Equipment Noise			Total
		Uncomfortable - Comfortable			Too noisy - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Number of People in Shared Office	1	11	5	7	10	7	6	23
	2	2	1	4	1	1	5	7
	3	2	0	1	2	0	1	3
	4	4	0	0	3	0	1	4
	5	3	1	0	2	2	0	4
	Total	22	7	12	18	10	13	41

Table 3-10 Cross-Tabulations of People in Shared Office and Reported Noise & Privacy

		Noise Distractions			Background Noise Levels			Total
		Too distracting - Comfortable			Too noisy - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Number of People in Shared Office	1	13	5	5	12	3	8	23
	2	1	3	3	1	2	4	7
	3	1	1	1	1	1	1	3
	4	3	0	1	3	0	1	4
	5	4	0	0	3	1	0	4
	Total	22	9	10	20	7	14	41

Table 3-11 Cross-Tabulations of People in Shared Office and Reported Noise Levels

		Visual Privacy			Conversation Privacy			Total
		Uncomfortable - Comfortable			Uncomfortable - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Desks in Cubicle Arrangement	N/A	15	11	10	18	5	6	36
	10	3	0	2	5	0	0	5
	Total	18	11	12	23	5	6	41

Table 3-12 Cross-Tabulations of Number of Cubicle Desks and Reported Privacy Levels

		Telephone Privacy			Voice and Equipment Noise			Total
		Uncomfortable - Comfortable			Too noisy - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Desks in Cubicle Arrangement	N/A	17	7	12	15	9	12	36
	10	5	0	2	3	1	1	5
	Total	22	7	12	18	10	13	41

Table 3-13 Cross-Tabulations of Number of Cubicle Desks and Reported Noise & Privacy

		Noise Distractions			Background Noise Levels			Total
		Too distracting - Comfortable			Too noisy - Comfortable			
		Score 1 or 2	Score 3	Score 4 or 5	Score 1 or 2	Score 3	Score 4 or 5	
Desks in Cubicle Arrangement	N/A	17	9	10	16	7	13	36
	10	5	0	0	4	0	1	5
	Total	22	9	10	20	7	14	41

Table 3-14 Cross-Tabulations of Number of Cubicle Desks and Reported Noise Levels

3.4 Hypothesis Three

Demographic factors moderate the linkage between each physical workstation environmental characteristic and satisfaction, comfort, and performance.

The descriptive findings regarding perceived comfort per office type were discussed briefly in hypothesis one, and are shown in Table 3-2. The regressions for workstation satisfaction and performance were calculated using binomial logistic regression according to their one corresponding question each on the BIU. The two response categories used were

"dissatisfied or neutral" (scores 1 thru 3) versus "satisfied" (scores 4 or 5) to ensure enough data points to be able to test for associations using SPSS. The comfort scores were calculated with linear regression as they are an average of the Likert scores on the BIU, which resulted in a scalar variable.

3.4.1 Descriptive Findings

Averages of employees' perceived comfort rating per office type are shown Table 3-2 as broken down by the type of office. Based on the descriptive analysis as indicated in the table, individuals with open offices reported the most opportunity for noise, daylighting and nature access, and privacy levels. The Likert scale is measured on a 1 to 5 scale where lower scores indicate areas of greatest potential improvement. For more information on the individual cross-tabulations by question, refer to Appendix C.

3.4.2 Regression Analysis

The following data illustrated in Tables 3-15 to 3-18 explores the potential moderating effects of the variables age, gender, time at company, and length of time assigned to workstation on the values of reported satisfaction, comfort, and performance levels. No demographic factors had statistically significant relationships on satisfaction, performance, or comfort levels. There was also no evidence of any relationships between the physical workstation characteristics and workstation satisfaction nor performance. The data suggests that there are main effects of windows with nature views, distance from workstation to window, and the presence of acoustic ceiling tiles on the variable of workstation comfort, evidenced by p-values of .001, .000, and .034 respectively. These results will be discussed in the next section.

Workstation Satisfaction (p-value)					
Independent variable	Main effects	x Age	x Gender	x Time at company	x Time at workstation
Office type	0.325	0.908	1.000	0.892	0.568
Number of people in shared office	0.792	0.963	1.000	1.000	0.713
Number desks in cubicles	0.677	0.822	1.000	0.999	0.999
Windows with nature view	0.338	0.624	1.000	0.560	0.190
Distance to windows	0.368	0.624	1.000	0.560	0.190
Desk type	1.000	1.000	--	--	--
Chair type	1.000	1.000	--	--	--
Acoustic tiles	0.677	0.954	--	0.844	0.463
Carpet	0.929	0.624	0.981	0.811	0.349
Cubicle material	0.731	0.628	1.000	0.225	0.999
Headphones	0.253	0.523	1.000	0.997	0.998

Table 3-15 Workstation Satisfaction Moderator Results Using Binomial Regression

Performance (p-value)					
Independent variable	Main effects	x Age	x Gender	x Time at company	x Time at workstation
Office type	0.518	0.722	0.908	0.884	0.808
Number of people in shared office	0.976	0.808	0.996	0.996	0.969
Number desks in cubicles	0.274	0.999	1.000	0.999	0.999
Windows with nature view	0.152	0.935	0.973	0.920	0.956
Distance to windows	0.100	0.935	1.000	0.920	0.956
Desk type	1.000	1.000	--	--	--
Chair type	1.000	1.000	--	--	--
Acoustic tiles	0.274	0.464	--	0.920	0.888
Carpet	0.775	0.169	0.633	0.729	0.769
Cubicle material	0.377	0.999	1.000	0.997	0.999
Headphones	0.951	0.216	1.000	0.429	0.565

Table 3-16 Employee Performance Moderator Results Using Binomial Regression

Workstation Comfort (p-value)					
Independent variable	Main effects	x Age	x Gender	x Time at company	x Time at workstation
Office type	0.155	0.607	0.393	0.644	0.077
Number of people in shared office	0.285	0.712	0.738	0.374	0.653
Number desks in cubicles	0.414	0.801	0.852	0.859	0.97
Windows with nature view	0.001	0.752	0.873	0.162	0.129
Distance to windows	0.000	0.752	0.873	0.162	0.129
Desk type	0.115	0.786	--	0.997	--
Chair type	0.111	0.852	--	0.997	--
Acoustic tiles	0.034	0.911	--	0.912	0.953
Carpet	0.508	0.362	0.677	0.225	0.712
Cubicle material	0.818	0.944	0.998	0.586	0.781
Headphones	0.326	0.279	0.314	0.104	0.219

Table 3-17 Workstation Comfort Moderator Results Using Linear Regression Analysis
Note: *Shaded ratings indicate statistical significance (p-values of .05 or less).*

CHAPTER 4

DISCUSSION

This study investigated the potential associations between a researcher's evaluation of the physical workstation environment versus employees' reported comfort, satisfaction, and performance levels in the space. The moderating effects of age, length of time assigned to workstation, gender, and time at company on the linkage between the observed and perceived environmental qualities were evaluated. Data was gathered through researcher observations of set characteristics of the physical workstation environment on the WVAT, the employee self-reported data gathered on the BIU, and various comments a subsect of respondents noted on the BIU. The data was then imported into Qualtrics Version 04/2019, SPSS Version 26, and Microsoft Excel Version 16.27 to conduct descriptive analysis. Inferential statistics was performed for part of the analysis. Per the above results, conclusions can now be drawn according to the three hypotheses.

4.1 Literature Trends for Descriptive Hypotheses

4.1.1 Spatial Density, Noise, and Privacy

For the most part, these results are intuitive. Research has shown that single occupant offices are associated with lower reports of visual distraction, increased comfort ratings, and better communication and project collaborating with peers (Brill, Weidemann, & BOSTI Associates, 2001). However, in recent years there has been a transition from traditional private offices to shared, bull pen (cubicles) and open-concept offices that stem largely from an

organization's desire to downsize space while increasing density (Duval, Charles, & Veitch, 2002). The inclusion of partitions inhibits employees' direct visual proximity to their co-workers but does little to impact the noise levels in the office. The comfort ratings of visual privacy support this idea. And for the questions regarding telephone and conversation privacy, being in any shared space can result in increased levels of noise and commotion as employees are conducting their individual work tasks in spaces with others present. Privacy is a human need, and as an employee's physical proximity to another's workstation increases, their performance and comfort can be negatively impacted due to distractions (Vischer, 1996; Bodin Danielsson & Bodin, 2009). Without imposed behavioral norms, or enforced office rules, there may not be a limit to the level of noise that can exist in the space. In her doctoral thesis, Bodin Danielsson found that the reported frequencies for privacy and noise complaints were higher than any other category, resulting in increased employee dissatisfaction levels (Bodin Danielsson, 2010b). In a study comparing responses before and after a move from a traditional office to an open office, employees reported much higher sound levels and noise disturbances, less privacy, and difficulty concentrating in the workplace (Kaarlela-Tuomata, Helenius, Keskinen, & Hongisto, 2009).

All of this affects the level of social interaction employees are both exposed to and have to adapt to in the workplace (Bodin Danielsson & Bodin, 2008; Duval et al., 2002). The fact that these trends were exhibited in the findings highlight the need for designers and architects to communicate with upper management. Superiors need to consider the consequences that these alternative office designs can have on employee well-being in the workplace, as their initial cost savings may have future implications that are not as favorable.

4.1.2 Daylight and Nature Views

The findings also support the trends found in office daylighting and window view accessibility. A 1967 study found that as the distance between employees and a window increased, their satisfaction decreased, and their desire to be located closer to a window was heightened (Markus, 1967; Aries, Veitch, & Newsham, 2010). Another study investigated daylight exposure on satisfaction and found the highest satisfaction scores were employees who were exposed to daylight but not physically adjacent to a window (Veitch, Geerts, Charles, Newsham & Marquardt, 2005; Aries et al., 2010). There is an abundance of health benefits that employees can reap by being located within window distance. Window views allow for mental breaks caused by fatigue, and those window views that are considered to be "attractive" have been found to lessen workplace discomfort caused by headaches and concentration issues (Kaplan, 2008; Kaplan, 1995; Aries et al., 2010). In other countries such as the Netherlands, window access in the workplace is mandatory, providing opportunities for employees to benefit from these conditions (Aries et al., 2010). If the United States were to implement such regulations, there is the potential for workers to receive innumerable health benefits.

4.1.3 Ergonomics

The implicated trends in employees' preference for comfortable furniture, such as adjustable-height ergonomic chairs, are also supported by literature. A PhD study by Miles (as cited in Vischer, 2008) found that a company's initial investment by replacing current furniture with ergonomic tables and chairs, as well as proper usage training for employees, resulted in a five-month payoff rate due to increased productivity levels (Vischer, 2008). Employers need to

consider the benefits that outweigh the up-front costs of the more expensive materials, as this is a tool that employees should readily have at their disposal (Vischer, 2008).

4.2 Implications of Moderating Factors on Comfort, Satisfaction, and Performance

4.4.1 Satisfaction by Moderating Demographic Factors

In this study neither main effects nor interactions were statistically significant for any of the independent variables nor moderating factors (age, gender, time spent at workstation, or time worked at company) on workplace satisfaction. This could be due to the fact that it was a correlational study, or that the potential relationship was not exhibited in the study due to geographic and sample limitations. Evidence shows aspects of the acoustic environment and availability of natural light have been largely supported in impacting workstation satisfaction (Vischer, 2008; Becker, 1981; Brennan, Chugh & Kline, 2002; Hedge, 1991; Humphries, 2005; Veitch et al., 2005). The relatively small sample size may explain why none of the coefficients were significantly different from zero at conventional levels. In other studies, daylight has been found to have a relationship with environmental satisfaction, as it was ranked highest when employees had visual access to daylight but were not beside it and exposed to glare issues (Veitch et al., 2005; Aries et al., 2010). The presence of sunlight through a window in office settings has been shown to have a direct positive relationship with job satisfaction (Leather, Pyrgas, Beale, & Lawrence, 1998). While the data regarding noise levels, disturbance occurrences, and privacy levels were not significant in this study, a 1994 study documented correlations between noise disturbances and reported environmental satisfaction (Sundstrom, Town, Rice, Osborn, and Brill, 2004).

4.4.2 Performance by Moderating Demographic Factors

Using binomial logistic regression, neither main effects nor interactions were statistically significant for the linkage between the physical work environment characteristics nor the moderating factors on workplace performance. In a study of an academic setting, students showed higher productivity rates by completing their math and reading assessments more quickly when their classrooms had windows than when they did not (Heschong Mahone Group, 1999; Hedge, 2000). These researchers found no correlation between environmental noise and reported performance levels, which was in contrast to results regarding satisfaction (Sundstrom et. al, 2004). The findings regarding noise disturbances and privacy are also supported in the same Sundstrom et. al, 2004 study.

4.4.3 Comfort by Moderating Demographic Factors

The comfort variable did show associations between a few work environment characteristics. There was a main effect of both windows with nature views and distance from workstation to window on perceived employee comfort level. The p-values for these associations were .001 and .000 respectively. There was also a main effect of presence of acoustic ceiling tiles on reported comfort level, with a p-value of .034. Moderating factor effects were not significant. Window view type and quality have also been seen to have effects on physical and psychological discomfort, as seen in a study by Aries et al., and follows what Heschong found in 2003 (Aries et al., 2010; Heschong, 2003). However, the same study by Aries et al. also found that there was no significant impact of window distance to an employee's workstation and their discomfort level, which is in contrast to the findings above. This may be affected by an outside factor, such as the mandate that office buildings in the Netherlands have window access (Aries et

al., 2010). Another study found that the presence of including sound-absorbing ceiling tiles in the design of the office space was linked to fewer reports of noise disturbances (Seddigh, Berntson, Jönsson, Bodin Danielson, & Westerlund, 2015).

CHAPTER 5

CONCLUSION

5.1 Overall Conclusions

The data collection in hypotheses one and two provided vast insights into how employees in this facility perceive their workstations as impacting their comfort, satisfaction, and performance at work. The majority of respondents work in shared offices. These, along with open offices, are prone to additional noise and privacy complaints as the spatial density of workers increases. A considerable number of employees are also stationed away from windows, limiting their access to daylight, and the reported nature views from the existing windows that exist are of a main road, parking lot, and construction site. Literature recommends that the most restorative types of nature views include serene water scenes, parks, or vibrant greenery (Ulrich, 1993, 1999; Ulrich & Gilpin, 2003. Most employees described access to windows and daylight as some of their important workplace needs, validating the initial logic of hypothesis one.

The descriptive comparisons between the actual and perceived findings of the WVAT and BIU tools showed that there were likely links between the accessibility of various physical work environment characteristics and employee rankings of their workstation comfort, satisfaction, and performance in the tests for hypothesis one and two. However, upon further analysis, the regression models showed that none of the aspects of the physical work environment were associated with employees' rated workstation satisfaction and performance levels. Nor did any moderating effects of demographic characteristics exist in the study. However, the comfort regression model did indicate that windows with nature views, the

distance from workstation to a window, and the availability of acoustic tiles were associated with increased comfort levels. These daylight and nature findings that relate to employee comfort are supported by various studies (Veitch, Geerts, Charles, Newsham, & Marquardt, 2005; Aries et al., 2010, Kaplan, 2008; Kaplan, 1995). Again, the findings in this study are inferential, as this was a case study investigation. Additional research is needed to look at these potential relationships more closely.

Overall, although the study did not find the prominent linkage between access to various physical work environment characteristics and employee perception as initially thought, it still contains merit. Findings suggest that more research should be conducted by management to guide strategic decision making for MOBs. A similar research study is recommended to identify key opportunities before implementing the chosen design into the office renovation. Additionally, when research findings are identified and completed, change management should be available to assist with the transition from old to new so that employees feel as though their opinions and concerns are being heard. Implementing a system led by professionals that are goal-driven, such as ADKAR trained, could assist companies in effectively managing the desired outcomes of these transitions. ADKAR is an acronym for awareness, desire, knowledge, ability, and reinforcement - all of which are outcome components of successful projects (Prosci, 2019).

5.2 Limitations & Impacts of Future Research

This study was subject to a few limitations in both scope and design. These may influence the replicability of the findings, and aid in the understanding of why certain hypotheses were not seen in the data. Future research should work to eliminate these gaps in order to gain a

better understanding of the physical aspects of the workstation environment and their effect on employee perceptions of their comfort, satisfaction, and performance.

5.2.1 Elimination of Aspects of Functional Comfort Model

The elimination of characteristics of the functional comfort model had various implications to the study design which may have impacted the data findings. This was because lighting, ventilation, and temperature questions were removed from the study because it was not possible to accurately measure them by the observer checklist visually. Finding accurate tools to conduct these measurements would have been a costly challenge, and their recordings may not have been entirely reliable unless measured over a period of time. Future research should find ways to include these observations for each office over the period of a day to increase consistency and allow for additional time samples to be gathered.

5.2.2 Inconsistent Number of BIU Survey Questions Measuring Satisfaction and Performance

This limitation is most likely the root cause of the unsupported hypothesis 3 regarding the moderating relationships between the physical workstation environment characteristics and employees' perceived comfort, satisfaction, and performance. The BIU survey is designed to measure functional comfort, not necessarily satisfaction and performance, even though they are components of this idea. This affects the way the BIU survey was designed, where the majority of questions are related to comfort or adequacy (which in this study was considered one in the same), whereas only one question is related to satisfaction and performance each. This lack of additional data points meant that the regressions for these variables had to be conducted

differently and may not be comparing the same level of detail as the comfort model. Researchers should consider the tools they select very carefully in the future, and adapt them if necessary, to ensure their study's validity.

5.2.3 Need for a More Comprehensive Pilot Study

While a small pilot study was conducted, a more comprehensive pilot study would have improved consistency in the results. Although some measures on the WVAT checklist were amended prior to data collection, there were a few that didn't make sense in practice, and had to be adjusted during the observations. One instance of this was regarding the question "Was there presence of a nature view?". As there was no definition of what constituted a nature view in the WVAT, there was a level of subjectivity left to the observer. There was also one question that had to be discarded due to the inconsistencies in workstation reporting. During the pilot study the questions on the survey or questionnaire should then be amended with definitions to ensure that respondents (and the researchers) understand what is being asked and answering questions consistently.

5.2.4 Single Site Issues

Because this case study only focused on one site, there is the possibility that in future iterations the results may not be replicable due to the single site selection. Therefore, it is required that additional testing using both metrics be conducted on multiple sites before alluding to the nature of the association/correlation. Preferably, this would be done with facilities of similar size and industry type.

5.2.5 Small Sample Size

Another limitation that was seen in the data was the limited response size for each category. The surveyed company had 51 participants that met the inclusion criteria. Of that sample, 41 employees participated. This meant a great response rate for the study, but because the respondents were skewed per office type, some categories (i.e.: open offices with partitions) only had responses from 5 employees. This resulted in responses that were skewed and deemed more significant than they may have been if more participants would have been asked. This is just another instance where comparing groups of office workers from various companies would have been beneficial. Researchers should keep this in mind when designing future studies.

5.2.6 Emotional Congruence Theory Implications

There are also theories that predispose humans to make presumptions about their workspaces depending on their mood. The emotional congruence theory explores the relationship between an individual's emotional state and their perception of environmental stimuli. This theory asserts that an individual's interpretation of a stimulus is affected by their emotional state at that instance of time and is therefore biased according to how they feel (Bower, 1981; Singer and Salovey, 1988; Niedenthal, Setturlund, and Jones, 1984). This could mean that if someone is overtly stressed or uncharacteristically happy, their perception of their work environment may be tainted by their existing emotional state (Ulrich, 1999; Ulrich & Gilpin, 2003). This is another potential bias that could have affected employee responses to the survey. Accommodating for this in a survey could be a challenge, but by increasing the sample of participants researchers may be able to gather enough responses that the data will regress toward the mean.

5.2.7 Potential Issues with Self-Report

There are significant limitations with the subjectivity of self-reported data. This stems from the idea that opinions can be skewed, as each individual is different, leading to response bias. There's also the possibility for a respondent to want to answer "correctly" regardless of the anonymity of the research, leading to social desirability bias (Rosenman, Tennekoon, & Hill, 2011). The addition of follow-up meetings to gather multiple data from the same respondents can also be affected by response-shift bias, where their opinion or answers could vary over time due to a variety of factors (Rosenman, Tennekoon, & Hill, 2011; Howard, 1980). Any of these could affect the integrity of the data, and therefore must be controlled with statistics whenever and wherever possible.

5.3 Implications on Field

This study was meant to be a case study investigating whether or not the accessibility of certain physical work environment characteristics affected employees' perceived levels of comfort, satisfaction, and performance at their workstation. The findings confirm the importance of the role of research to determine the most effective method of office design that will both benefit the employer and balance the health and needs of employees. The integration of design interventions that promote employee health and wellness may be challenging to quantify in a return on investment (ROI), but they are facets of a company culture that aid in attracting and retaining top talent (Timm, Austin Gray, Curtis, & Chung, 2018). There is not a one-size-fit-all method that should be used for renovating office spaces, and the more consideration taken by companies and designers during the process, along with effective change management

procedures, the more likely employees will report feeling comfortable and satisfied with the end product.

APPENDIX A

Workstation Visual Assessment Tool (WVAT)

Q1 Workstation Number

_____

End of Block: Sequencing

Start of Block: Privacy

Q2 Type of Office

- ○ Private - Single occupant (1)
- ○ Private- Shared (2)
- ○ Open- With partitions/cubicles (3)
- ○ Open- No partitions (4)
- ○ Other (5)

Display This Question:
If Type of Office = Other

Q15 If other, explain

_____

Display This Question:
If Type of Office = Private- Shared

Q3 How many people work at this shared desk?

_____

Display This Question:

If Type of Office = Open- With partitions/cubicles

Q4 How many desks are in the cubicle arrangement?

_____

End of Block: Privacy

Start of Block: Lighting

Q7 Does this workstation have an individual window?

- Yes (1)
- No (2)

Q6 Does this workstation have access to daylight?

- Yes (1)
- No (2)

Q8 What type of lighting is available in the workstation?

- Task (1)
- Overhead (2)
- Dynamic (3)

End of Block: Lighting

Start of Block: Nature access

Display This Question:

If Does this workstation have an individual window? = Yes

Or Does this workstation have access to daylight? = Yes

Q9 Does the window have a nature view?

- Yes (1)
- No (2)

Q10 Does the workstation display photos of nature?

- Yes (1)
- No (2)

Q11 Does the workstation display nature artwork?

- Yes (1)
- No (2)

End of Block: Nature access

Start of Block: Ergonomic Features

Q14 What kind of desk does this workstation have?

- Sitting (1)
- Standing (2)
- Combination desk (3)

Q16 Does this workstation have an ergonomic chair?

- ○ Yes (1)
- ○ No (2)

Q17 Does this workstation have other comfortable furniture available?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If Does this workstation have other comfortable furniture available? = Yes

Q18 If yes, explain

_____

End of Block: Ergonomic Features

Start of Block: Noise

Q19 Does this workstation have any of the following noise-blocking features?

- ☐ Cubicle material (1)
- ☐ Headphones (2)
- ☐ Headset (3)
- ☐ White noise machine (4)
- ☐ Noise dampening panels (5)

Q20 Is the ventilation system noisy?

- ○ Yes (1)
- ○ No (2)

End of Block: Noise

APPENDIX B

Demographic questions:

How long have you worked for this company?: _____

How long have you been sitting at this workstation?:

How old are you?: _____

What gender do you identify as?: _____

APPENDIX C

		Noise Distractions (Q23)					
		Too distracting		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	4	4	3	2	14
	Private - Shared	1	8	2	4	1	16
	Open - With Partitions	2	3	0	0	0	5
	Open - No Partitions	0	3	3	0	0	6
	Total	4	18	9	7	3	41

Table C-1 Cross-Tabulation of Observed Type of Office by Perceived Noise Distractions

		Background Noise Levels (Q24)					
		Too much noise		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	5	1	6	1	14
	Private - Shared	2	6	4	2	2	16
	Open - With Partitions	0	4	0	1	0	5
	Open - No Partitions	0	2	2	2	0	6
	Total	3	17	7	11	3	41

Table C-2 Cross-Tabulation of Observed Type of Office by Background Noise Levels

		Voice & Equipment Noises (Q25)					
		Too much noise		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	3	5	5	0	14
	Private - Shared	3	5	2	4	2	16
	Open - With Partitions	1	2	1	0	1	5
	Open - No Partitions	0	3	2	1	0	6
	Total	5	13	10	10	3	41

Table C-3 Cross-Tabulation of Observed Type of Office by Voice & Equipment Noises

		Ventilation Noise (Q26)					
		Too much noise		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	1	5	4	3	14
	Private - Shared	0	0	5	6	5	16
	Open - With Partitions	0	0	0	3	2	5
	Open - No Partitions	0	1	0	4	1	6
	Total	1	2	10	17	11	41

Table C-4 Cross-Tabulation of Observed Type of Office by Ventilation Noise

		Outside Noise Levels (Q28)					
		Too much noise		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	0	1	2	3	8	14
	Private - Shared	0	0	1	5	10	16
	Open - With Partitions	0	0	0	1	4	5
	Open - No Partitions	0	0	0	4	2	6
	Total	0	1	3	13	24	41

Table C-5 Cross-Tabulation of Observed Type of Office by Outside Noise Levels

		Visual Privacy (Q29)					
		Uncomfortable		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	2	4	2	5	14
	Private - Shared	1	9	4	1	1	16
	Open - With Partitions	0	3	0	1	1	5
	Open - No Partitions	1	1	3	1	0	6
	Total	3	15	11	5	7	41

Table C-6 Cross-Tabulation of Observed Type of Office by Visual Privacy

		Conversation Privacy (Q30)					
		Uncomfortable		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	3	4	4	2	14
	Private - Shared	5	6	1	2	2	16
	Open - With Partitions	2	3	0	0	0	5
	Open - No Partitions	1	2	0	1	2	6
	Total	9	14	5	7	6	41

Table C-7 Cross-Tabulation of Observed Type of Office by Conversation Privacy

		Telephone Privacy (Q31)					
		Uncomfortable		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	1	2	5	4	2	14
	Private - Shared	2	8	2	2	2	16
	Open - With Partitions	2	3	0	0	0	5
	Open - No Partitions	1	3	0	1	1	6
	Total	6	16	7	7	5	41

Table C-8 Cross-Tabulation of Observed Type of Office by Telephone Privacy

		Overall Lighting Comfort (Q32)					
		Uncomfortable		Neutral		Comfortable	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	0	0	6	4	4	14
	Private - Shared	0	0	6	7	3	16
	Open - With Partitions	0	1	0	2	2	5
	Open - No Partitions	0	1	4	0	1	6
	Total	0	2	16	13	10	41

Table C-9 Cross-Tabulation of Observed Type of Office by Overall Lighting Comfort

		Access to Daylight (Q35)					
		Inadequate		Neutral		Adequate	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	5	3	2	0	1	14
	Private - Shared	2	3	5	1	4	16
	Open - With Partitions	3	2	0	0	0	5
	Open - No Partitions	2	1	2	0	1	6
	Total	12	9	9	1	6	41

Table C-10 Cross-Tabulation of Observed Type of Office by Access to Daylight

		View of Nature (Q36)					
		Inadequate		Neutral		Adequate	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	5	3	2	0	4	14
	Private - Shared	2	3	5	1	5	16
	Open - With Partitions	3	2	0	0	0	5
	Open - No Partitions	2	1	2	0	1	6
	Total	12	9	9	1	10	41

Table C-11 Cross-Tabulation of Observed Type of Office by View of Nature

		Facilitates Work (Performance Measure) (Q37)					
		Makes Difficult		Neutral		Makes Easier	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	0	0	6	4	4	14
	Private - Shared	0	2	7	6	1	16
	Open - With Partitions	1	1	2	1	0	5
	Open - No Partitions	0	0	4	2	0	6
	Total	1	3	19	13	5	41

Table C-12 Cross-Tabulation of Observed Type of Office by Performance

		Workplace Satisfaction (Satisfaction Measure) (Q38)					
		Dissatisfied		Neutral		Satisfied	
		Score 1	Score 2	Score 3	Score 4	Score 5	Total
Type of Office Observed	Private - Single Occupant	2	0	3	5	4	14
	Private - Shared	0	1	7	6	2	16
	Open - With Partitions	1	1	1	2	0	5
	Open - No Partitions	0	0	5	0	1	6
	Total	3	2	16	13	7	41

Table C-13 Cross-Tabulation of Observed Type of Office by Satisfaction

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